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SEMIDEFINITE PROGRAMMING AND APPLICATIONS IN FREE MATERIAL OPTIMIZATION

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Summary: This talk deals with nonlinear smooth optimization problems with equality and inequality constraints, as well as semidefinite constraints on symmetric matrix-valued functions. Semidefinite Programing (SDP) constraints are involved in several structural optimization problems. This is the case of free material optimization, that needs positive definite elasticity matrices. Constraints on the fundamental structural frequencies can be stated as SDP constraints. We describe some basic concepts involved in nonlinear optimization, beginning by unconstrained function minimization and following with constrained problems. Finally we present a new semidefinite programming algorithm, FDIPA_GSDP, obtained as a generalization of the well known Feasible Direction Interior Point Algorithm for nonlinear smooth optimization, FDIPA. FDIPA_GSDP makes iterations in the primal and dual variables to solve the first order Karush-Khun- Tucker optimality conditions. Given an initial interior point, FAIPA_GSDP generates a descent interior sequence, converging to a local solution of the problem. At each iteration a feasible descent direction is defined. A line search along this direction looks for a new interior point with lower objective. To compute the search direction, the present algorithms simply require the solution of two linear systems with the same matrix. Feasible iterates are essential in applications where the calculus of some of the constraints requires the satisfaction of a set of so called "hard constraints".
This is a requirement in some applications of advanced materials optimization, to ensure that the stiffness matrix has a unique solution. Global convergence to stationary points is proved. Some structural optimization test problems were solved very efficiently, without need of parameters tuning.